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ABSTRACT

The Timed Interval Categorical Observation Recorder (TICOR), a portable, battery powered microcomputer designed to automate the collection of sequential and simultaneous behavioral observations and their associated durations, was developed to overcome problems in gathering subtle interaction analysis data characterized by sequential flow of behaviors, simultaneous occurrence of several behaviors, and the duration of the behaviors. TICOR has been used in studies of teacher effectiveness, bilingual education, mental health, and physical education. Data are recorded electronically on a microcassette by pressing the appropriate keys of the 64 on the keyboard, and are later analyzed by the TICOR Data Analysis Computer (DAC) to provide summary reports of the variable frequencies, durations, and profiles of sequential and simultaneous variables. Available subject specific TICOR-DAC monitoring procedures include STUDAT, which monitors student attention to task; INSTAT, which monitors teacher instructional strategies and their relationship to teacher attention; EQUAT, which monitors teacher questioning and student attention. Many advanced interobserver reliability and data analysis procedures are available. The microcomputer is programmable in FORTRAN, and has the capability of collecting covert responses from student response pads and analog input from autonomic responses. (Author/CHV)

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MICROCOMPUTER APPLICATIONS IN INTERACTION ANALYSIS

by

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MICROCOMPUTER APPLICATIONS IN INTERACTION ANALYSIS

ABSTRACT

Interaction analysis data are typically collected using paper and pencil measures. With such measures there is considerable difficulty in identifying the sequential flow of behaviors, the simultaneous occurrence of several behaviors, and the duration of the behaviors. To overcome these problems, the Timed Interval Categorical Observation Recorder (TICOR) was developed. The TICOR is a portable, battery powered microcomputer designed to automate the collection of sequential and simultaneous behavioral observations and their associated durations. Up to 64 variables may be defined by the researcher (e.g. instructing, questioning, or illustrating) and coded by depressing one of the 64 keys on the TICOR keyboard. Second and third order modification of variables are also possible by depressing the two or three keys which have been previously defined. The data are recorded electronically on a microcassette which is later analyzed by the TICOR Data Analysis Computer (DAC) to provide summary reports of the variable frequencies and durations and profiles of sequential and simultaneous variables. Advanced interobserver reliability and data analysis procedures (e.g. SPSS) are available. The microcomputer is programmable in FORTRAN and has the capability for collecting covert responses from student response pads and analog input from autonomic responses (e.g. heart rate, GSR, etc.).

The system has been used in teacher effectiveness studies, bilingual education studies, mental health research, and physical education research.

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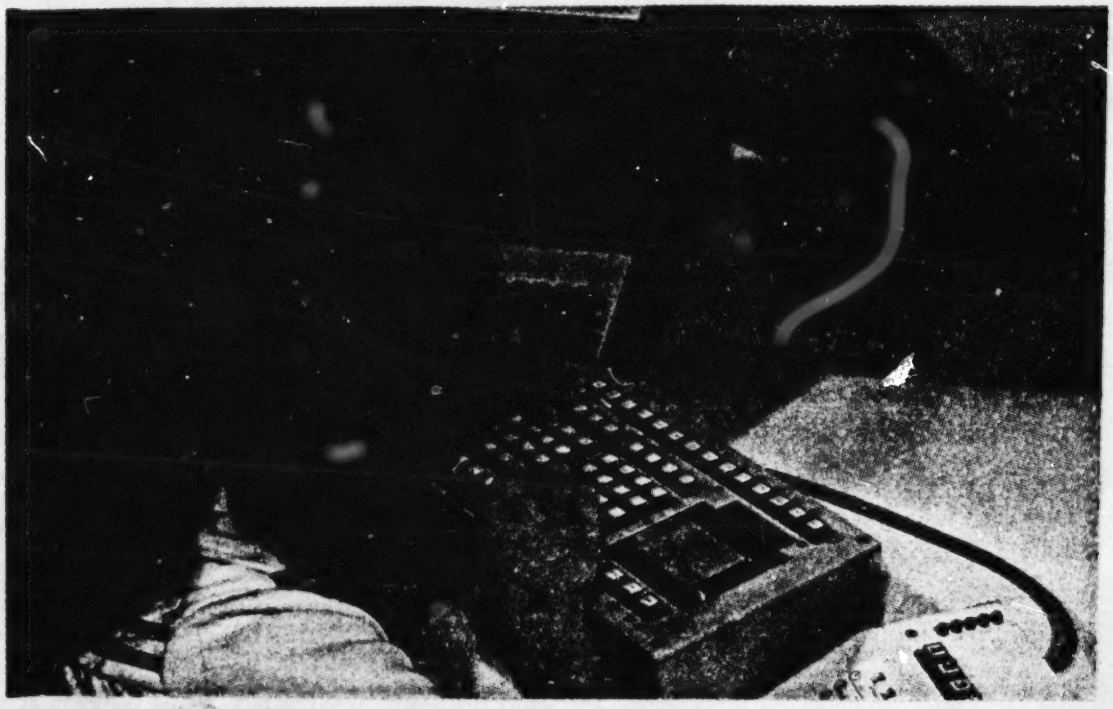

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INTRODUCTION

The perennial research goal for teaching has been to discover how the behavior of more effective teachers differs from the behavior of less effective teachers. This goal continues to be an elusive one. The thousands of studies which have been conducted during the last decade tell us little more than if there are behavioral differences between effective and ineffective teachers, these differences are subtle ones--too subtle to be detected by the research methods which have been employed. Many researchers have expressed the opinion that the differences lie not in the frequencies of discrete acts but rather in the complex patterning of these acts.

A series of studies being conducted at Brigham Young University (BYU) are designed to compare the patterns of behavior characteristic of more effective elementary school teachers with the patterns of behavior characteristic of less effective elementary school teachers. These studies employ a technological innovation developed at BYU which allows the convenient recording and analysis of more complex patterns of behavior than researchers have typically in the past. This technological innovation is the Timed Interval Categorical Observation Recorder-Data Analysis Computer (TICOR-DAC) system. The TICOR-DAC system is a computerized recording device developed by a BYU research team under the direction of Dr. Rex A. Wadham.

DESCRIPTION OF THE TICOR-DAC SYSTEM

The TICOR-DAC System is a portable, battery-powered, special-purpose computer designed to automate the collection of large amounts of data representing simultaneous and sequential occurrences of events. Data representing the time of occurrence and of up to 4,000 distinct events happening at rates from a few per hour to several hundred per second can be recorded on each side of a micro cassette tape for later analysis by the TICOR-DAC. Smaller than a typical briefcase, TICOR was designed to be used in the classroom or in the field,

drawing up to eight hours of power from its internal, rechargeable battery power supply.

The system is designed to record observed events, which the machine defines as the closure of one of the 48 keys on the operator console or one of 320 additional keys which can be connected externally. There are two general modes of operation called "label mode" and "duration mode." The label mode is used for labeling an observational period or for writing annotations to follow a recorded observational period. The duration mode automatically records the times of every event entered including the periods of latency between events.

Alphanumeric functions may be assigned to the keyboard when needed without limiting the number of keys available for other special functions. Thus, in a classroom situation, an operator may define the console keys in such a way as to keep track of general classroom and teacher activities, labeling some keys "instructing," "illustrating," "visual aids," etc. The external keys are located on up to 64 small keypads with five keys each. These are referred to as the Subject Response Pads for obtaining covert response from students. Typical arbitrary labels may proceed from "I don't understand" to "I understand completely," or "I am thinking in Spanish" to "I am thinking in English," etc.

To facilitate orderly operation of the Subject Response Pad System, each remote keyboard also has five indicator lights which may be used to guide students concerning when a response is desired and what types of responses are appropriate for given questions. A free pupil response mode is also possible. In addition, a number of indicator lights and displays are available on the operator's console to keep observers informed of operating sequences.

TICOR-DAC can also be used to monitor concurrently pupil analog input, such as muscle stress or other biological data, with the external teacher/pupil data.

Internally, TICOR-DAC is composed of a Z80 microprocessor running at two to six MHZ, with 2048 bytes of memory in the standard version, expandable to 6144. Large-scale integrated support microcircuits scan

the 64 keys on the keyboard, keep track of the passage of time, control a digital tape memory system, display pertinent data to the operator, convert analog data to digital format and store them in internal memory, and compile data entered from the external keypads. Dedicated to the Read-Only Memory are 2048 bytes of memory storage which store the basic program to oversee these operations as a main routine and a series of subroutines. Every job which is conceivable to the researcher can be custom-programmed and loaded into the system from the same tape cassettes used for data recording. Thus, it is possible to customize every detail of TICOR-DAC's operation by reprogramming.

VERSATILITY OF TICOR-DAC DATA

The TICOR-DAC system can provide both ratio and nominal data on a large number of variables during each observation period. These variables may be derived from teacher/student interaction or any other behavior mode either overt or covert.

Nominal data are used to distinguish type of teaching, teacher background, training, or student background and student performance. These procedures allow the relationship between teacher and/or pupil classroom behavior and such demographic data to be succinctly evaluated.

Since the system records most variables in ratio form, many standard statistical techniques can be utilized, such as discriminant analysis, factor analysis, multivariate analysis of variance and covariance, cluster analysis, canonical correlation, etc. In addition, specialized analyses have been developed to process the unique data produced by TICOR, i.e., comparison of profiles, sequence clustering, Markov matrices. The potential uses of these new data are as multitudinous as they are promising.

STATEMENT ON A SUBJECT SPECIFIC TICOR-DAC RESEARCH PROCEDURE

For research purposes, the functional aspect of TICOR-DAC is its keyboard. The keyboard allows an observer to record, with the press of a button, not only the frequency but also the duration, simultaneity and sequence of a predefined set of behavioral categories. Uni-dimensional as well as multidimensional categories may be recorded through th use of first, second and third order modifiers modifying a primary event. The data are recorded on micro magnetic tape, and processed on the DAC computer.

Before the TICOR-DAC system can be used, a set of descriptive behavioral categories must have been selected and defined. This set of categories must satisfy three criteria. First, the categories must be mutually exclusive and exhaustive. Second, the categories must be functionally defined and easily discriminatable by each observer. Third, the categories must be capable of resolving the research hypothesis, such as distinguishing between effective and ineffective teachers. A search of the literature reveals a large number of categories which satisfy the first and second of these criteria but, generally, there are few that have been well researched to satisfy the third.

In an effort to meet all three of these criteria, the categories for our present line of research were derived from a recent study reported by Berliner.[1] Berliner presented ethnographic descriptions of the behavior of several pairs of teachers to a team of judges. Each pair of teachers consisted of a more effective teacher and a less effective teacher. The judges were asked to identify and to label ways in which the behavior of the more effective teachers differed from that of the less effective teachers. The result of the study was a list of 61 concepts which the judges considered useful in differentiating between the two groups of teachers. A number of these concepts were selected

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[1]David C. Berliner, William J. Tikunoff, "The California Beginning Teacher Evaluation Study: Overview of the Ethnographic Study." Journal of Teacher Education 27 Vol. 1 (Spring 1976): 24-30.

and modified for use in one of four TICOR data gathering procedures.

STUDAT PROCEDURE

The first modified procedure monitors student attention to task (STUDAT). Students are selected randomly and monitored individually for observable attention to task including their covert responses from the subject response pads. Each student has a demographic profile input file to facilitate a rich analysis of the STUDAT data. From this procedure, which will later include the use of automatic response behavior, it is anticipated that much will be learned concerning student motivation and learning outcomes.

INSTAT PROCEDURE

The second procedure monitors teacher instructional strategies and their relationship to teacher attention (INSTAT). The INSTAT data collection procedure consists of various student/teacher interaction variables which correspond with student covert responses. There are 10 procedures presently being used in a bilingual setting to collect, analyze and present these data. We are able to, through this procedure, investigate the learning strategies used by minority/bilingual/bicultural students. A special emphasis is placed on the use of the subject response pads (see Figure 1 for photo of student using the equipment). The 10 INSTAT procedures are listed below:

1. The subject response pads are being used to obtain data in which language the students are thinking. This can be broken down into instructional or free time activities. A two-way contingency table can be constructed, showing the responses according to these two activities and by ability of the student being divided into high, medium and low achievement categories. These contingency table data can be analyzed using the log-linear model for categorical data analysis.

2. The language students use in making oral responses during various classroom interaction situations can be analyzed in a two-way contingency table where the second category is English or Spanish language dominance in the student's background. The comparisons could also be made using the log-linear model.

3. The question of which teacher activities elicit thinking responses in English or Spanish is of interest. This can be analyzed by ethnicity of students, by achievement levels,

Figure 1

Student demonstrates use of the Subject Response Pad of the TICOR-DAC system.

by student language dominance and by the teacher's language dominance. This leads to a four-way design and, since the basic response is again categorical, the log-linear model would be used to analyze this design.

4. The pads can be used to obtain data on whether or not the students are understanding what is going on at the moment. Using the same factors as in Item 3 above, a four-way design is generated using the student response pad data which would likewise be analyzed using the log-linear model.

5. The frequency of students' thinking in English or Spanish can be analyzed by language dominance of the student, achievement level, ethnicity and sex. This leads again to a four-way design which can be analyzed using the long-linear model.

6. The time spent by the teacher speaking in either Spanish or English can be compared for the various instructional routines or free time activities engaged in by the teacher. Both the duration and frequency data would be compared using an analysis of variance.

7. The amount and percentage of time spent by the target and/or other students, speaking Spanish or English, in various instructional, routine or free time activities can be compared using an analysis of variance.

8. A profile can be obtained showing the entire spectrum of classroom interaction activities by the teachers. The profile for the Spanish dominant teachers can be compared with that of the English dominant teacher.

9. Profiles as in Item 8 above for the more effective teachers can be compared with profiles of those judged to be less effective.

10. The difference between several types of classroom or teacher interactions can be examined more critically using discriminant analysis. The pattern of separation among the various classroom teachers could be examined in this way and broken down for closer observation. Thus, the contribution of individual variables to this separation comes out more clearly. The success of the statistical separation could be tested by following the discriminant analysis with a classification analysis. In this phase, each observation period could be classified according to the classroom or teacher it appears to resemble most, and the percentage of correct hits thus constitutes a verification of the success of the separation.

EQUAT PROCEDURE

The third procedure monitors teacher equity of attention to the minority learner (EQUAT). This procedure uses the same demographic profile as described previously. The emphasis in EQUAT is to identify the nature and duration of attention a teacher provides the minority learner in comparison to the non-minority learner.

The two procedures being used to analyze EQUAT data are:

1. The patterns of teacher attention to various ethnic, sex and ability groups in the bilingual classroom can be compared using both frequency and duration. The comparison could be made statistically using multivariate analysis of variance followed by discriminant analysis. The discriminant analysis would show which variables are important to separate the above groups and would give a profile of the contribution of these variables. These same comparisons would also be made by teacher ethnic group.

2. The patterns of verbal interaction with the students in the bilingual classoom can be compared for the English dominant teacher and the Spanish dominant teacher using a special profile analysis program developed at BYU for TICOR-DAC research. In this program an overall comparison is made using all the variables simultaneously as well as two methods of comparing the individual variables. One method ignores the other variables which are present, while the other takes into account the relationships of each variable with the other variables.

QUAT PROCEDURE

The fourth procedure monitors teacher questioning and student attention (QUAT). This procedure monitors five forms of student response behavior, both verbal and, where feasible, non-verbal, as well as five forms of teacher questioning behavior.

The student response behaviors are:

1. those responses which can be classified as being a correct response to a teacher directive, question or instructional stimulus;

2. those that represent a partially correct response;

3. those which are incorrect;

4. those forms of student behavior which suggest the student was unable to respond;

5. a student question asking for teacher clarification.

The teacher questioning behaviors are:

1. a question pertaining to classroom procedure,
2. a question requiring a recall of fact,
3. a question requiring the processing of information,
4. a question that allows for an opinion to be given,
5. a question requesting a demonstration be made (i.e., of a skill, etc.).

Types of questions asked, method of directing a question, latency of response time provided by the teacher, student response type, nature of the feedback provided by the teacher to a student response and teacher affect to student are all a part of the QUAT analysis. This procedure is capable of identifying hidden biases of teacher preferences and other related areas.

TICOR-DAC DATA ANALYSIS SOFTWARE PROCEDURES

Programs are available to implement all of the procedures to be described. Most of these programs were developed at BYU specifically for the TICOR-DAC system. Others are commercially prepared programs readily available here (and elsewhere) for processing TICOR-DAC data:

1. TCR - This provides a general overview of frequency and duration data on each event and groups of events for the period, day and study timespans. The same type of data originating from several sources may be grouped and examined as a whole.
2. PACK - Prominent sequential patterns may be found using this pattern recognition program. Absolute and conditional probabilities of all pattern occurrences are also calculated. Patterns common to several teachers are noted as well as patterns which are unique to a particular teacher or group.
3. CNTX - This program allows the researcher to investigate the context of one or more pivotal events, capturing the nth events that precede and the nth events that succeed the event set. Programs also provide a tally of the occurrences and latency between the set of pivotal events and their related set of response events.
4. Chains - This program allows the researcher to examine the sequence of events between a set of possible beginning, internal and ending events.

5. Discriminant Analysis - This procedure isolates variables which best separate subjects or groups of subjects. The degree of separation, using discriminant function scores, is also useful information available with this procedure.

6. Classification Analysis - In this procedure, each observation case is examined to see if the subject or group of subjects to which it belongs can be identified. The percentage of correct classifications indicates that a pattern unique to each subject or group of subjects has been uncovered.

7. Cluster Analysis - If separation is not the primary interest, cluster analysis can be used to examine groupings of observation cases, or groupings of variables. These groupings will help reveal the nature underlying structure of the data.

8. Comparative Analysis - Detailed comparisons of any two subjects or groups of subjects can be made using this procedure. The average level of occurrence of each variable constitutes a profile for the subject or group of subjects. These profiles can be compared for two subjects or groups of subjects using each variable separately as well as all variables combined in a simultaneous comparison.

   A single subject or group of subjects can also be compared to a norm or standard. For example, the profile for an ineffective teacher can be compared to the normative profile for highly effective teachers. The significant differences in classroom behavior can be readily noted and used as a basis for inservice training.

9. Variable Selection - Since the TICOR-DAC can be used to readily observe a very large number of variables, there is a need to reduce this mass of variables to a tractable number which show the essential makeup of the process being observed. If primary emphasis is on distinguishing subjects or groups of subjects, variable reduction can readily be performed by a step-wise discriminant analysis. If a direct comparison of groups is not of interest, reduction can be obtained by other techniques based upon principal components. These techniques extract the variables which preserve the most information.

10. Other Multivariate Analyses - Since the TICOR-DAC is essentially multivariate in nature, various other multivariate techniques are sometimes useful. A few of these will be mentioned. Factor analysis can be employed to probe for underlying variables which explain a large part of the "surface activity" of the variables under observation. Canonical correlation can be used to study the relationship between two sets of variables, for example, between teacher and pupil variables. Regression analysis can be performed using multiple independent variables and either univariate or multivariate dependent variables. Analysis of variance

can be used with either univariate or multivariate dependent variables.

SPSS PROGRAMS

The TICOR-DAC system has direct access to the Statistical Package for Social Science (SPSS) Programs. The following programs have either already been used or are judged to be potentially useful for analyzing TICOR data.

1. Crosstabs - This is a program for creating two-way or higher dimensional tables from categorical data. Various measures of association are also calculated.

2. Breakdown - This is a program for creating a two-way or higher dimensional table from categorical data. Various measures of association are also calculated.

The remaining programs in this list are sufficiently well described by title.

3. Multiple Regression Analysis.

4. Analysis of Variance and Covariance.

5. Discriminant Analysis.

6. Canonical Correlation Analysis.

7. Factor Analysis.